FEM-supported machine learning for residual stress and cutting force analysis in micro end milling of aluminum alloys

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Abstract

This study delves into a Bayesian machine learning (ML) framework designed to comprehensively characterize cutting force and residual stress in the micro end milling process across a diverse range of aluminum alloys. The foundation of this investigation rested on acquiring dependable training data through finite element method simulations, encompassing material properties and processing parameters as inputs, while the output targets included residual stress in both the transverse and cutting directions, as well as cutting force divided into feed force and thrust force. The outcomes were remarkable, unveiling high predictive accuracy for both residual stress and cutting force, with a slight advantage in residual stress prediction. Moreover, the study revealed the significant influence of output target values on the weight functions of input parameters, highlighting distinct dependencies between each output target and the corresponding input features. This investigation elucidated that predicting residual stress and cutting force in micro end milling represents a multifaceted process contingent upon the interplay of material properties and processing parameters. The intricate nature of this process underscores the Bayesian ML model's potential as a robust and highly accurate approach, adept at effectively encapsulating these complex objectives.

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Ethics declarations

Conflict of interest

The authors declare that there is no conflict of interest.

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